

**UNITED STATES PATENT APPLICATION FOR:**

**FIELD CHANGEABLE RENDERING SYSTEM FOR A COMPUTING DEVICE**

**INVENTORS:**

**MICHAEL DIAMOND**

**LUC BISSON**

**LUDGER MIMBERG**

**JOSEPH WALTERS**

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Alberta Gamble  
Signature

ALBERTA GAMBLE  
Name

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Date of signature

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**MOSER, PATTERSON & SHERIDAN, L.L.P.**  
595 Shrewsbury Avenue  
Suite 100  
Shrewsbury, NJ 07702

# FIELD CHANGEABLE RENDERING SYSTEM FOR A COMPUTING DEVICE

## BACKGROUND OF THE INVENTION

### 1. Field of the Invention

**[0001]** This invention relates generally to computer hardware and relates more particularly to a field changeable rendering system for a computing device.

### 2. Description of the Background Art

**[0002]** Contemporary computing devices typically incorporate a graphics card that enables a computing device to rapidly process graphics related data for graphics intensive applications, such as gaming applications. A graphics card generally comprises a printed circuit board (PCB) upon which a plurality of circuit components (such as memory chips and the like) and a graphics processing unit (GPU) are mounted. In “closed platform” computing devices such as laptop computers, cellular telephones and personal digital assistants (PDAs) (*i.e.*, devices that use processors and are not easily changed by a user), the graphics card is mounted directly and permanently to the motherboard of the computing device.

**[0003]** One drawback to mounting the graphics card directly to the motherboard is that this fixed configuration impedes a user’s ability to upgrade the computing device’s graphics system. Specifically, in order to take advantage of an improved graphics system, the user typically must purchase an entirely new computing device, which is much more costly than a simple replacement of the graphics system in the existing computing device. The same is true for upgrading other motherboard-mounted rendering devices, such as audio chips.

**[0004]** A second drawback is that the pace of graphics innovations that can be conveniently delivered to computing device users is hindered, because the implementation of on-board devices is typically limited by a design cycle of approximately nine to twelve months.

**[0005]** Thus, there is a need in the art for a field changeable rendering system for a computing device.

## SUMMARY OF THE INVENTION

**[0006]** One embodiment of a field changeable rendering system includes an output device interfaced to a motherboard, a fixed rendering device mounted to the motherboard for generating information to be output on said output device, a connector for attaching a field-changeable rendering card to the motherboard, said field-changeable rendering card capable of housing a discrete rendering device for generating information to be output on said output device and detection circuitry for detecting that a field-changeable rendering card housing a discrete rendering device is coupled to said connector and causing information from said field-changeable rendering card housing a discrete rendering device to be output on said output device.

**[0007]** One advantage of the disclosed rendering system is that it is compatible with a plurality of graphics cards and systems, thereby enabling a computing device user to upgrade the existing device's graphics system. Thus, the user is not forced to purchase an entirely new computing device in order to take advantage of graphics innovations. This advantage is particularly significant for users of portable computing devices, such as laptop computers, cellular telephones and PDAs, or other devices traditionally having fixed graphics functionality such as video game consoles.

**[0008]** A further advantage of the disclosed rendering system is that it enables upgrades to low voltage differential signaling (LVDS) features, without the need for an additional (and typically costly) device that is capable of operating at LVDS data rates.

## BRIEF DESCRIPTION OF THE DRAWINGS

**[0009]** FIG. 1 is a side view illustrating a field changeable rendering system, wherein the rendering system is a graphics card, according to one embodiment of the present invention.

**[0010]** FIG. 2 is a top plan view illustrating a graphics card for use in field changeable rendering system of FIG. 1, according to one embodiment of the present invention;

**[0011]** FIGS. 3A-B are tables illustrating one embodiment of a pinout for the edge connector illustrated in FIG. 2;

**[0012]** FIGS. 4A-C are tables containing contact pin descriptions for each signal type identified in FIGS. 3A-B;

**[0013]** FIG. 5 is a table summarizing the power that must be supplied through an edge connector from a motherboard to a graphics card, according to one embodiment of the present invention;

**[0014]** FIG. 6A is a schematic diagram illustrating a configurable graphics system according to one embodiment of the present invention;

**[0015]** FIG. 6B is a schematic diagram illustrating graphics system according to another embodiment of the present invention;

**[0016]** FIG. 7A is a schematic diagram illustrating a user-upgradeable graphics system, according to one embodiment of the present invention; and

**[0017]** FIG. 7B is a schematic diagram illustrating a user-upgradeable graphics system, according to another embodiment of the present invention.

## DETAILED DESCRIPTION OF THE INVENTION

**[0018]** FIG. 1 is a side view illustrating a field changeable rendering system 100, according to one embodiment of the present invention. Rendering system 100 is a graphics system, and is adaptable for use with any type of computing device, including, without limitation, a desktop computer, server, laptop computer, palm-sized computer, personal digital assistant, tablet computer, game console, cellular telephone, computer-based simulator and the like. As will be explained in further detail below in conjunction with FIGS. 6A-7B, graphics system 100 is configured to ensure compatibility with a plurality of field changeable graphics cards.

**[0019]** Generally, system 100 is configured to interface with a computing device motherboard 102 in lieu of a conventional graphics card and includes, without limitation, a graphics card 104 and an interface assembly 150. Graphics card 104 includes a GPU and a plurality of circuit components including memory (not shown) mounted to a first face 101, typically facing away from motherboard 102. Graphics

card 104 further comprises a card connector 106 positioned along an edge 105 of graphics card 104 and adapted to engage interface assembly 150. Several embodiments of field changeable graphics cards suitable for use in rendering system 100 are described in co-pending, commonly assigned United States Patent Application No. xx/xxx,xxx, filed xx/xx/xx by Bisson et al. (Attorney Docket No. NVDA/P001196), which is herein incorporated by reference.

**[0020]** As also described in further detail below in conjunction with FIGS. 2-5, rendering system 100 is configured to interface with motherboard 102 without being directly mounted to motherboard 102. This is enabled by interface assembly 150, which includes, without limitation, one or more supports 108 and an edge connector 114. Supports 108 are mounted to motherboard 102 and extend upward therefrom to engage graphics card 104. Supports 108 are adapted to stably maintain graphics card 104 in a spaced-apart orientation relative to motherboard 102. In one embodiment, supports 108 are sized to maintain a distance  $d$  between graphics card 104 and motherboard 102 that is approximately 4mm.

**[0021]** Also as described in conjunction with FIG. 2, edge connector 114 is mounted to motherboard 102 and includes a lengthwise channel 116 having a plurality of contacts disposed on upper and lower surfaces 118, 120. The contacts are adapted for engaging card connector 106 on graphics card 104, for routing external and internal interfaces from graphics card 104 to motherboard 102.

**[0022]** FIG. 2 is an isometric view illustrating one embodiment of an edge connector 200 according to the present invention. Edge connector 200 is adapted to route all internal and external interfaces from a graphics card (*e.g.*, graphics card 104 of FIG. 1) to a motherboard of a computing device. Edge connector 200 comprises an elongated body 202 having a longitudinal slot 204 formed therein. Longitudinal slot 204 is sized to receive an edge of a graphics card connector (*e.g.*, card connector 106). In one embodiment, longitudinal slot 204 is sized to accommodate card thicknesses of up to 1.2 mm. Contact pins (not shown) disposed on top and bottom surfaces 206, 208 of longitudinal slot 204 are adapted to interface with contacts on a card connector.

**[0023]** FIGS. 3A-B are tables illustrating one embodiment of a pinout for edge connector 200. Each contact pin on edge connector 200 is associated with an individual

signal (*e.g.*, power input, ground and the like). In the embodiment illustrated, edge connector 200 utilizes a 230-pin card-edge connection system, wherein contact pins on edge connector 200 are rated for 0.5 A steady state current. FIGS. 4A-C are tables containing contact pin descriptions for each signal type identified in FIGS. 3A-B. Input/output classifications in FIGS. 4A-C are relative to a GPU mounted on the graphics card. References to “MXM module” indicate a graphics card according to the present invention.

**[0024]** FIG. 5 is a table summarizing the power that must be supplied by the motherboard to a graphics card, *i.e.*, through edge connector 200, according to one embodiment of the present invention. If the motherboard’s power supply equals or exceeds the power requirements summarized in FIG. 5, a graphics card interfaced to an edge connector according to the present invention (*e.g.*, edge connector 200) will run at full speed. However, the interface will also allow a graphics card to detect power supply limitations of the motherboard and to automatically throttle its clocks to stay within the limits of the available power.

**[0025]** In addition to the power requirements summarized in FIG. 5, a motherboard must meet a plurality of additional system requirements in order to effectively interface to a graphics system of the present invention. For example, in one embodiment, the motherboard is required to place a serial ROM that connects to the DDCC\_DAT and DDCC\_CLK signals (*e.g.*, connector pins 220 and 222 in FIG. 3B). In addition, the motherboard must provide back drive isolation and level shifting, for all DDC lines, VGA\_HSYNC and VGA\_VSYNC signals (*e.g.*, connector pins 151 and 153). Furthermore, the motherboard must provide power to the computing device LVDS panel, and must route all RGB signals and TV\_out signals with 37.5 Ohms impedance. In one embodiment, the motherboard is also required to have output filters on all VGA output lines and on all TV output lines, the filters being positioned as closely as possible to the connector pins. Input filters are required on the DVI\_B\_HPD and DVI\_A\_HPD lines (*e.g.*, connector pins 191 and 217), and the graphics card will provide level shifting and clamping for the DVI\_B\_HPD and DVI\_A\_HPD signals.

**[0026]** In one embodiment, an edge connector according to the present invention (*e.g.*, edge connector 200) is adapted to detect a graphics mode of a computing device, and to

cause display interfaces to be routed from a graphics card to the motherboard accordingly. Specifically, the PRSNT#1 connector pin on the edge connector (*e.g.*, pin 134 in the pinout of FIGS. 3A-B) is adapted to detect if a graphics upgrade, such as any one of the graphics cards disclosed in U.S. Patent Application No. xx/xxx,xxx, has been implemented in the computing device. In one embodiment, a voltage detected by the PRSNT #1 connector pin indicates the presence of a graphics upgrade. For example, a high voltage detected by the PRSNT#1 connector pin indicates that a “dummy” or “loop-through” card (*e.g.*, a card with no graphics processing unit) is interfaced to the edge connector, as explained in further detail in conjunction with FIGS. 6A and 7A below. Alternatively, a low voltage detected by the PRSNT#1 connector pin indicates that a graphics upgrade such as a graphics card is interfaced to the edge connector, as explained in further detail in conjunction with FIGS. 6B and 7B below.

[0027] FIG. 6A is a schematic diagram illustrating a configurable graphics system 600, according to one embodiment of the present invention. The output topology illustrated in FIG. 6A depicts a manufacturing-end graphics configuration (*i.e.*, graphics system 600 is incorporated during assembly of the computing device). Graphics system 600 comprises a fixed (*e.g.*, mounted to the motherboard) rendering device such as a standard integrated graphics processor (IGP) 612 (driven in one embodiment by a Northbridge chip set, not shown), a loop-through card 650, and a plurality of output display panels 604-610 for video graphics array (VGA), television (TV), low voltage differential signaling (LVDS) and digital video interface (DVI) signals, all interfaced to a motherboard. The display output signals are generated by IGP 612 in conjunction with loop-through card 650, as described further below.

[0028] Loop-through card 650 may be implemented in graphics system 600 in place of a conventional LVDS capable device. As described above, the PRSNT #1 connector pin on the edge connector detects a high voltage and sends a corresponding signal to the Northbridge chip set indicating the presence of loop-through card 650. Consequently, the Northbridge outputs LVDS signals to the edge connector, in one embodiment connecting the signals to the IGP\_LVDS connector pins. The passive loop-through card 650 completes the circuit paths between the output signals and the LVDS panel input signals. Thus, the edge connector, in conjunction with loop-through card 650, enables a computing device user to implement LVDS features without the need to implement

complex (and costly) traditional LVDS-capable devices.

**[0029]** In one embodiment, the graphics system 600 further supports DVI. In this embodiment, DVI signals are output to the DVI\_A connector pins (*e.g.*, connector pins 219, 221, 225, 227, 231, 233, 237 and 239 in FIG. 3B) on the edge connector and routed to loop-through card 650, which further comprises a discrete rendering device such as a transmission minimized differential signaling (TMDS) transmitter for driving TMDS outputs on received signals. TV and VGA signals are output from the Northbridge chip set to IGP 612 in accordance with standard IGP operation.

**[0030]** In one embodiment, graphics system 600 further comprises a plurality of stuffing resistors 614a and 614b (shown in phantom) adapted for completing the circuits from IGP 612 and from loop-through card 650 to output display panels 604-610. During assembly of a computing system, a manufacturer may configure graphics system 600 to operate in the mode described (*e.g.*, incorporating loop-through card 650) by closing the circuit paths through resistors 614a and leaving the circuit paths through resistors 614b open.

**[0031]** Alternatively, as illustrated in FIG. 6B, a manufacturer may close the circuit paths through resistors 614b and leave the circuit paths through resistors 614a open, in order to implement an active graphics card. In this embodiment, graphics system 600 comprises a graphics card 660 in place of loop-through card 650. Graphics card 660 may be configured in a manner similar to any one of the graphics cards described in U.S. Patent No. xx/xxx,xxx, and includes a discrete rendering device such as a graphics processing unit. Graphics card 660 generates substantially all display output signals, as described further below.

**[0032]** As described above, the PRSNT #1 connector pin on the edge connector detects a low voltage and sends a corresponding signal to the Northbridge chip set indicating the presence of graphics card 660. Consequently, the Northbridge outputs a peripheral component interface (PCI) Express signal to the edge connector, which routes the signal to graphics card 660. VGA, TV, LVDS and DVI signals are subsequently generated by graphics card 660. As described above, stuffing resistors 614b complete the circuits from graphics card 660 to display panels 604-610.



**[0033]** FIG. 7A is a schematic diagram illustrating a graphics system 700 according to one embodiment of the present invention. The output topology illustrated in FIG. 7A depicts a user-upgradeable configuration. That is, a user may upgrade graphics system 700 on demand, by simply exchanging one field-exchangeable graphics card for another. Graphics system 700 is substantially similar to graphics system 600 illustrated in FIG. 6A and comprises an IGP 712, a loop-through card 702, and a plurality of display panels 704-710 for VGA, TV, LVDS and DVI signals. The display output signals are generated by IGP 712 in conjunction with loop-through card 702, as described further below.

**[0034]** LVDS and DVI signals are output by the Northbridge to the edge connector as described above in conjunction with FIG. 6A. The passive loop-through card 702 completes the circuit paths between the output signals and the LVDS and DVI panel input signals. TV and VGA signals are output from the Northbridge chip set to IGP 712 in accordance with standard IGP operation. In one embodiment, graphics system 700 further comprises a plurality of muxes 714 adapted for receiving and transmitting IGP-initiated signals (*e.g.*, for VGA and TV signals). During assembly of a computing system, a manufacturer may configure graphics system 700 to operate in the mode illustrated in FIG. 7A (*e.g.*, incorporating loop-through card 702) as a default.

**[0035]** FIG. 7B is a schematic diagram illustrating graphics system 700 in an upgraded mode. Graphics system 700 is substantially similar to graphics system 600 illustrated in FIG. 6B and comprises an IGP 702, a plurality of display panels 704-710 for VGA, TV, LVDS and DVI signals and an active graphics card 760 in place of loop-through card 702.

**[0036]** When the presence of graphics card 760 is detected, the Northbridge sends a PCI Express signal through the edge connector and to graphics card 760. Muxes 714 are configured to automatically reconfigure to connect VGA and TV circuit paths to graphics card 760.

**[0037]** An edge connector according to the present invention may thus be configured to enable a computing device user to upgrade an existing device's graphics system with minimal expense. Because the edge connector is adapted to work with a plurality of field-changeable graphics cards, the user is not forced to purchase an entirely new

computing device in order to take advantage of graphics innovations. This advantage is particularly significant for users of portable computing devices, such as laptop computers and PDAs, in which graphics systems are frequently difficult or impossible to alter.

**[0038]** A further advantage of the disclosed edge connector is that it enables upgrades to LVDS features. Typical devices capable of operating at LVDS data rates tend to be rather costly. However, by configuring the edge connector of the present invention to enable LVDS signals to “loop through” a passive card, the versatility of the graphics system is enhanced with minimal cost to the user.

**[0039]** Moreover, though the present invention has been described in terms of graphics cards, those skilled in the art will appreciate that the invention may be adapted for use with other devices that are typically hardwired to a motherboard, such as audio chips and the like.

**[0040]** Thus, the present invention represents a significant advancement in the field of computing device graphics systems. An edge connector is provided that enables a plurality of field-changeable graphics systems to interface to a single computing device motherboard. The edge connector thus maximizes the graphics options that may be implemented in an existing computing device, allowing computing device users greater ability to take advantage of graphics innovations.

**[0041]** Furthermore, the present invention grants more flexibility to computing device manufacturers, since it removes the approximately nine to twelve month design cycle for on-board implementations. The present invention also enables the build-to-order, stock-to-order and field repair of any of the systems disclosed, which is a significant advancement for a global economy having needs for just-in-time manufacturing and inventory management.

**[0042]** Those skilled in the art will appreciate that although the present invention has been described in the context of closed platform computing devices such as laptop computers, cellular telephones and PDAs, the present invention may be adapted for use with any device that uses a processor and is not easily changed by a user, such as automotive navigation systems, entertainment systems, all-in-one personal computers,

printers and the like. Moreover, although the present invention has been described in the context of standardized, field changeable graphics cards, the present invention may be deployed in other form factors such as credit card polymer substrates with embedded chips, and postage stamp-sized, self-contained devices, among others.

**[0043]** Although the invention has been described above with reference to specific embodiments, persons skilled in the art will understand that various modifications and changes may be made thereto without departing from the broader spirit and scope of the invention as set forth in the appended claims. The foregoing description and drawings are, accordingly, to be regarded in an illustrative rather than a restrictive sense.